

Optical Generation/Radiative Recombination

The next physical mechanisms we have to consider for generation/recombination are photon transition. This mechanism occurs primarily in one step and is therefore a direct generation/recombination mechanism. There are two partial processes involved. For radiative recombination, an electron loses energy on the order of the band gap and moves from the conduction band to the valence band. For optical generation, an electron moves from the valence band to the conduction. In silicon, band to band generation/recombination is insignificant. This effect, however, is important for narrow gap semiconductors and semiconductors whose specific band structure allows direct transitions. By assuming a capture rate C_c^{OPT} and an emission rate C_e^{OPT} , the involved partial processes can be written as

$$R_{np}^{OPT} = C_c^{OPT} np, \quad 3-339$$

for recombination and

$$G_{np}^{OPT} = C_e^{OPT} \quad 3-340$$

for generation.

These rates must be equal in thermal equilibrium so that

$$C_{np}^{OPT} = C_c^{OPT} n_{ie}^2 \quad 3-341$$

The total band to band generation/recombination is the difference of the partial rates, which equates to

$$R_{np}^{OPT} = C_c^{OPT} (np - n_{ie}^2). \quad 3-342$$

In ATLAS, C_c^{OPT} and can be defined by `COPT` on the `MATERIAL` statement or implemented using a C-Interpreter routine. To turn on the optical recombination/ generation model, define the `OPTR` keyword on the `MODELS` statement.

Auger Recombination

Auger recombination occurs through a three particle transition whereby a mobile carrier is either captured or emitted. The underlying physics for such processes is unclear and normally a more qualitative understanding is sufficient [245].

Standard Auger Model

Auger Recombination is commonly modeled using the expression [68]:

$$R_{Auger} = AUGN (pn^2 - nn_{ie}^2) + AUGP (np^2 - pn_{ie}^2) \quad 3-343$$

where the model parameters `AUGN` and `AUGP` are user-definable in the `MATERIAL` statement (see Table 3-75 for its default value). You can activate this model with the `AUGER` parameter from the `MODELS` statement.